ERDC/CERL TR-01-24

Construction Engineering
Research Laboratory

US Army Corps
of Engineers®
Engineer Research and
Development Center

Site Evaluation for Application of Fuel Cell Technology

Picatinny Arsenal, NJ

Michael J. Binder, Franklin H. Holcomb, and
William R. Taylor

February 2001

Foreword

In fiscal years 93 and 94, Congress provided funds for natural gas utilization equipment, part of which was specifically designated for procurement of natural gas fuel cells for power generation at military installations. The purchase, installation, and ongoing monitoring of 30 fuel cells provided by these appropriations has come to be known as the "DOD Fuel Cell Demonstration Program." Additional funding was provided by: the Office of the Deputy Under Secretary of Defense for Industrial Affairs & Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research & Development Program (SERDP); the Assistant Chief of Staff for Installation Management (ACSIM); the U.S. Army Center for Public Works (CPW); the Naval Facilities Engineering Service Center (NFESC); and Headquarters (HQ), Air Force Civil Engineer Support Agency (AFCESA).

This report documents work done at Picatinny Arsenal, NJ. Special thanks is owed to the Picatinny Arsenal point of contact (POC), Hyman Izraeli, for providing investigators with access to needed information for this work. The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Michael J. Binder. Part of this work was performed by Science Applications International Corp. (SAIC), under Contract DACA88-94-D-0020, task orders 0002, 0006, 0007, 0010, and 0012. The technical editor was William J. Wolfe, Information Technology Laboratory. Larry M. Windingland is Chief, CEERD-CF-E, and L. Michael Golish is Chief, CEERD-CF. The associated Technical Director was Gary W. Schanche. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

Contents

Foreword **2**

List of Figures and Tables **4**

1 Introduction **5**

Background 5
Objective 6
Approach 6
Units of Weight and Measure 7

2 Site Description **8**

Site Layout 8
Electrical System 8
Steam/Hot Water System 9
Space Heating System 9
Space Cooling System 9
Fuel Cell Location 10
Fuel Cell Interfaces 10

3 Economic Analysis **13**

4 Conclusions and Recommendations **17**

Appendix: Fuel Cell Site Evaluation Form **18**

CERL Distribution **25**

Report Documentation Page **26**

List of Figures and Tables

Figures

1 Picatinny Arsenal site layout....9
2 Picatinny Arsenal fuel cell location....10
3 Boiler Plant water process diagram....11
4 Picatinny Arsenal fuel cell layout and interfaces....12

Tables

1 Companion ERDC/CERL site evaluation reports....7
2 Picatinny Arsenal electricity consumption....13
3 Picatinny Arsenal natural gas consumption....14
4 Picatinny Arsenal electric rate schedule, Jersey Central Power & Light Schedule, GT–General Service/Transmission....14
5 Picatinny Arsenal fuel cell savings....16

1 Introduction

Background

Fuel cells generate electricity through an electrochemical process that combines hydrogen and oxygen to generate electricity. Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States have exempted fuel cells from requiring operating permits. Today's natural gas-fueled fuel cell power plants operate at electrical conversion efficiencies of 40 to 50 percent; these efficiencies are predicted to climb to 50 to 60 percent in the near future. In fact, if the heat from the fuel cell process is used in a cogeneration system, efficiencies can exceed 85 percent. By comparison, current conventional coal-based technologies operate at efficiencies of 33 to 35 percent.

Phosphoric Acid Fuel Cells (PAFCs) are in the initial stages of commercialization. While PAFCs are not now economically competitive with other more conventional energy production technologies, current cost projections predict that PAFC systems will become economically competitive within the next few years as market demand increases.

Fuel cell technology has been found suitable for a growing number of applications. The National Aeronautics and Space Administration (NASA) has used fuel cells for many years as the primary power source for space missions and currently uses fuel cells in the Space Shuttle program. Private corporations have recently been working on various approaches for developing fuel cells for stationary applications in the utility, industrial, and commercial markets. Researchers at U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). CERL has successfully executed several research and demonstration work units with a total funding of approximately $55M.

As of 30 November 1997 commercially available fuel cell power plants and their thermal interfaces have been installed at DOD locations. CERL managed 29 of these installations. As a consequence, the Department of Defense (DOD) is the owner of the largest fleet of fuel cells worldwide. CERL researchers have developed a methodology for selecting and evaluating application sites, have supervised the design and installation of fuel cells, and have actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers. This accumulated expertise and experience has enabled CERL to lead in the advancement of fuel cell technology through major efforts such as the DOD Fuel Cell Demonstration Program, the Climate Change Fuel Cell Program, research and development efforts aimed at fuel cell product improvement and cost reduction, and conferences and symposiums dedicated to the advancement of fuel cell technology and commercialization.

This report presents an overview of the information collected at Picatinny Arsenal, NJ along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report (see Table 1).

Objective

The objective of this work was to evaluate Picatinny Arsenal as a potential location for a fuel cell application.

Approach

On 2 and 3 February 1994, Science Applications International Corporation (SAIC) visited Picatinny Arsenal (the site) to investigate it as a potential location for a 200 kW phosphoric acid fuel cell. This report presents an overview of information collected at the site along with a conceptual fuel cell installation layout and description of potential benefits. The Appendix to this report contains a copy of the site evaluation form filled out at the site.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No.
Pine Bluff Arsenal, AR	TR 00-15
Naval Oceanographic Office, John C. Stennis Space Center, MS	TR 01-3
Fort Bliss, TX	TR 01-13
Fort Huachuca, AZ	TR 01-14
Naval Air Station Fallon, NV	TR 01-15
Construction Battalion Center (CBC), Port Hueneme, CA	TR 01-16
Fort Eustis, VA	TR 01-17
Watervliet Arsenal, Albany, NY	TR 01-18
911th Airlift Wing, Pittsburgh, PA	TR 01-19
Westover Air Reserve Base (ARB), MA	TR 01-20
Naval Education Training Center, Newport, RI	TR 01-21
U.S. Naval Academy, Annapolis, MD	TR 01-22
Davis-Monthan AFB, AZ	TR 01-23
Picatinny Arsenal, NJ	TR 01-24
U.S. Military Academy, West Point, NY	TR 01-28
Barksdale Air Force Base (AFB), LA	TR 01-29
Naval Hospital, Naval Air Station Jacksonville, FL	TR 01-30
Nellis AFB, NV	TR 01-31
Naval Hospital, Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, CA	TR 01-32
National Defense Center for Environmental Excellence (NDCEE), Johnstown, PA	TR 01-33
934th Airlift Wing, Minneapolis, MN	TR 01-38
Laughlin AFB, TX	TR 01-41
Fort Richardson, AK	TR 01-42
Kirtland AFB, NM	TR 01-43
Subase New London, Groton, CT	TR 01-44
Edwards AFB, CA	TR 01-Draft
Little Rock AFB, AR	TR 01-Draft
Naval Hospital, Marine Corps Base Camp Pendleton, CA	TR 01-Draft
U.S. Army Soldier Systems Center, Natick, MA	TR 01-Draft

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

1 ft	=	0.305 m
1 mile	=	1.61 km
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

Picatinny Arsenal is located in Dover, NJ, approximately 30 miles west of Newark. The Site is a research, development, and test site for advanced weapon systems. Throughout the year, temperatures range from 6 °F to over 90 °F.

The central power plant (building 506) was built around 1910 and has a footprint of approximately 24,000 sq ft. Building 506 provides steam throughout the base for space heating, hot water, and humidity control. The central power plant operates 24 hours/day, 365 days per year. There is no condensate return loop on the steam distribution system so the three boilers operate on 100 percent makeup water. The fuel cell was evaluated at the central power plant for preheating the boiler feed water.

The central plant has an estimated average electric demand of 450 kW. There is a 750 kW back-up generator at the plant in case the utility grid goes down. The minimum boiler feed water load throughout the year occurs in the summer and is about 20,000 lb/hr.

Site Layout

Figure 1 presents the site layout for the central power plant facility. Transformers, electrical panels, and the location of the water softeners are shown. Water for the boilers is taken from Lake Picatinny and processed through filters on the second level, just below the water softeners. The water softeners are located on the 3rd level up from the ground floor. An open trench (covered by metal sheets) extends from the north side of the building towards the salt tanks and is adjacent to the incoming natural gas supply for the building.

Electrical System

The central power plant is supplied in part by two, 2400/480 volt transformers (750 and 1,500 kVA), which are located on the east side of the building next to Babbit Road. The electrical switch gear for these transformers are directly inside the building from the transformers.

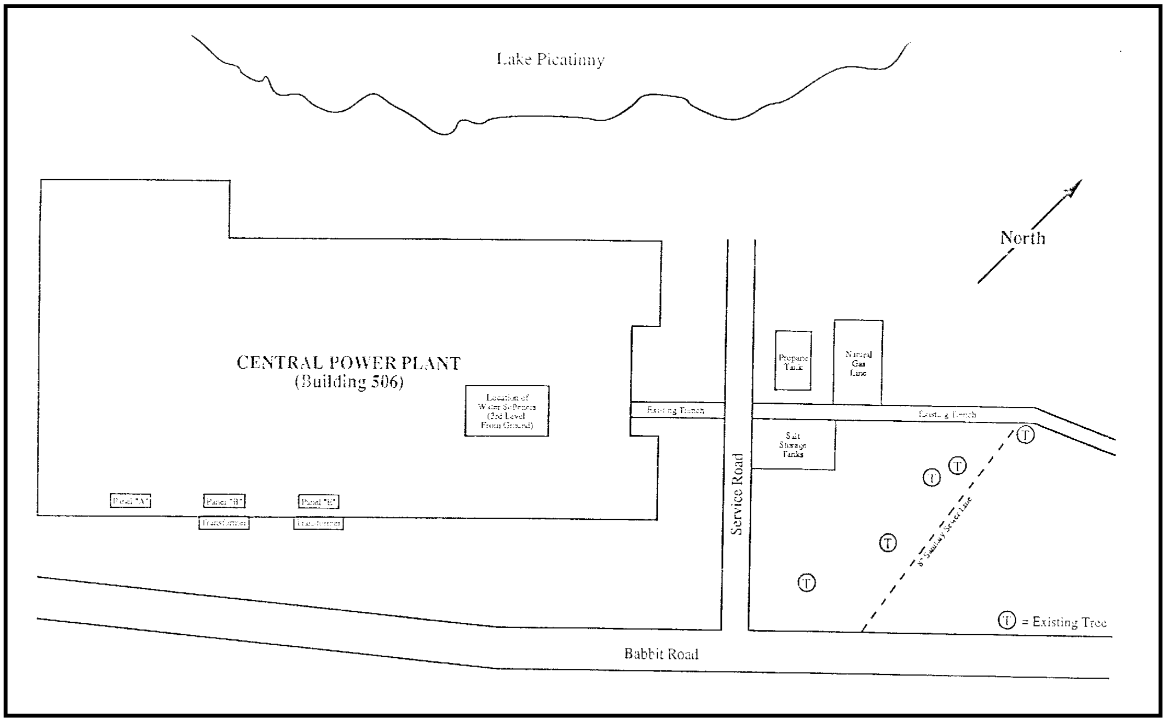

Figure 1. Picatinny Arsenal site layout.

Steam/Hot Water System

The central power plant has two 150,000 lb/hr Combustion Engineering boilers and a third 75,000 lb/hr boiler (manufacturer unknown). Water is taken from Lake Picatinny and run through water filters and softeners before entering two deaerators. From the deaerators, makeup water is fed to the boilers. Since there is no condensate return on the steam distribution system, the boiler uses 100 percent makeup water.

Space Heating System

The central steam system supplies heat to individual buildings using radiant heat.

Space Cooling System

Individual buildings have their own cooling systems. There are no absorption chillers being driven by the central steam system. However, steam is used for humidity control (reheat) in several clean rooms.

Fuel Cell Location

The proposed location for the fuel cell is north of the central power plant building near the salt storage tanks. The location is approximately 60 ft from the edge of the building across a small service road. Currently, there is a grassy area next to a cement pipe trench where the fuel cell could be located. Two trees would need to be removed to make room for the fuel cell.

Figure 2 presents the location of the proposed fuel cell site along with proposed thermal and electric runs. The thermal piping run will be approximately 200 ft from the fuel cell to the interface piping (about 130 ft to building, 70 ft to interface piping). The electric connection at the present site of the transformer will be approximately 250 ft from the fuel cell (about 120 ft to building, 130 ft to electrical panels). The adjacent natural gas line will be tapped off and run over to the fuel cell (about 25 ft).

Fuel Cell Interfaces

There are two 2400/480 volt transformers providing a portion of the electric power to the central power plant building. These transformers are rated at 750 kVA and 1500 kVA.

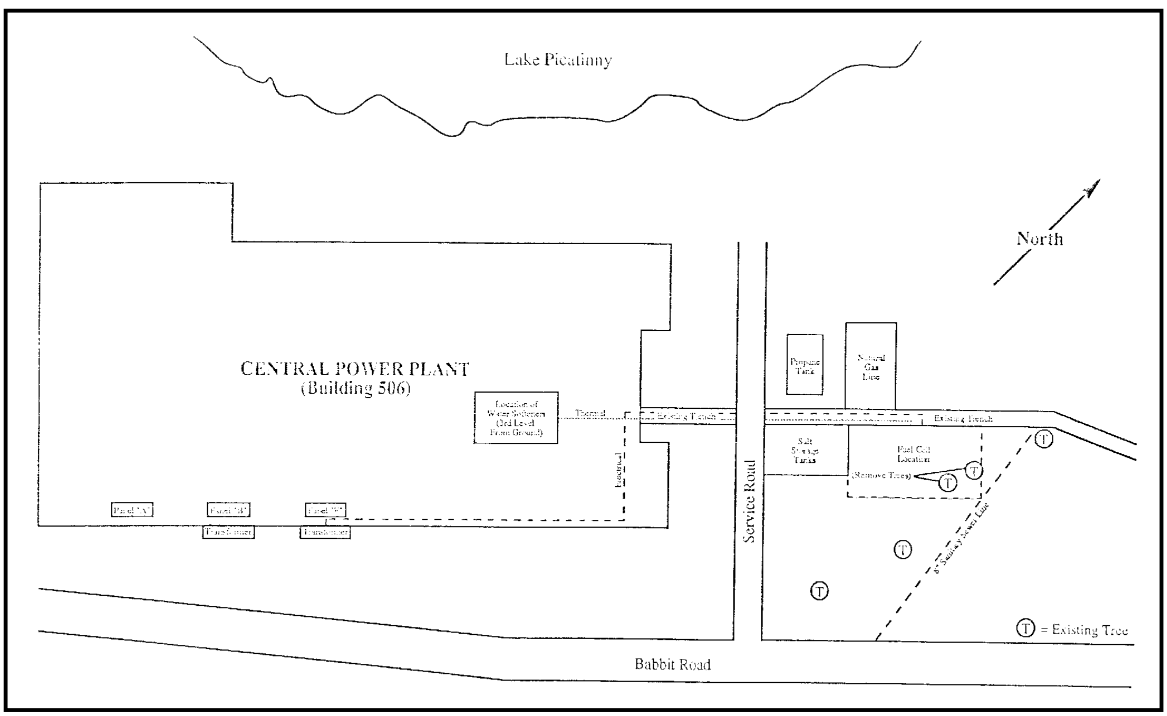

Figure 2. Picatinny Arsenal fuel cell location.

The fuel cell can be tied to into the 480 volt side of either transformer. There are two existing 480 volt breaker boxes, but the equipment is old. It may be best to install a new breaker. The Site would like to hook-up a portion of the central power plant load to the grid-independent output terminals on the fuel cell in order to have the fuel cell operate as a back-up power source when the utility grid goes down. The site is currently investigating appropriate isolated loads that are under 200 kW.

The proposed fuel cell thermal interface is to pre-heat the boiler makeup water (see Figure 3). Based on hand log data for several days in July 1994, the minimum makeup water flow was 40 gal/min (20,000 lb/hr / 8.35 lb/gal / 60 min/hr). The central steam distribution system is an open system with no condensate return. It is proposed that 25 gpm of makeup water be routed through the fuel cell, heated and returned to the 6-in. makeup water line. The water should be routed to the fuel cell after the water softeners and returned prior to the deaerators. At an average inlet temperature of 60 °F, the fuel cell will heat 25 gpm to about 116 °F and provide 700 kBtu of heat to the boiler makeup water. In the summer when Lake Picatinny reaches about 80 °F, the 25 gpm could be heated up to about 136 °F and still provide 700 kBtu of heat.

If the Site were to install two PC25 fuel cells, the 40 gpm makeup water requirement in the summer time (assuming an 80 °F inlet temperature from Lake Picatinny) would yield a total of 1.4 MBtu of thermal at an average temperature of 150 °F. Figure 4 shows the proposed layout of the fuel cell site area.

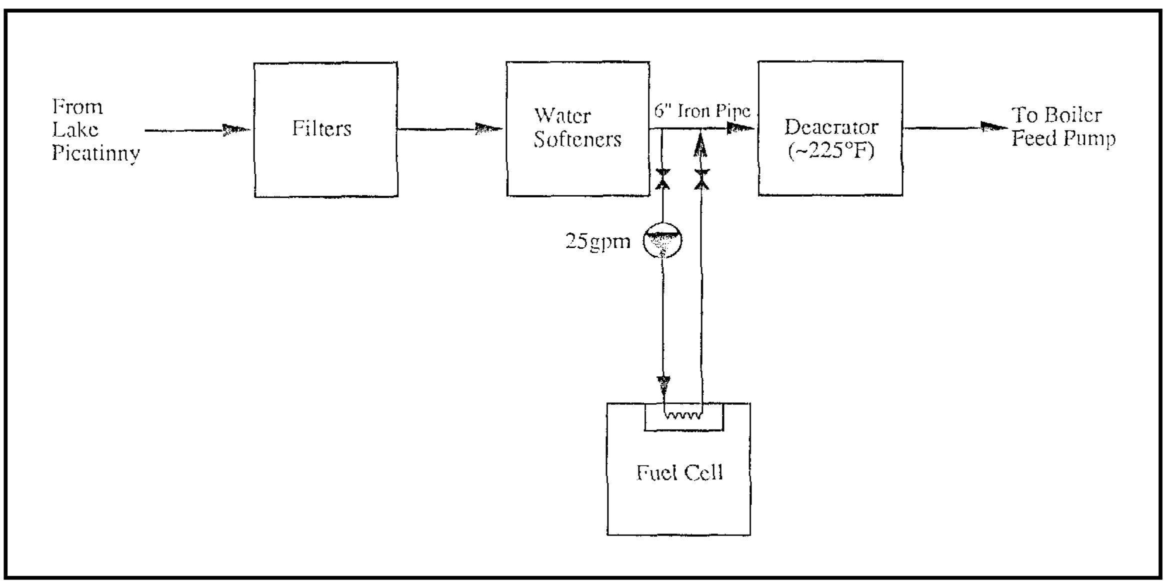

Figure 3. Boiler Plant water process diagram.

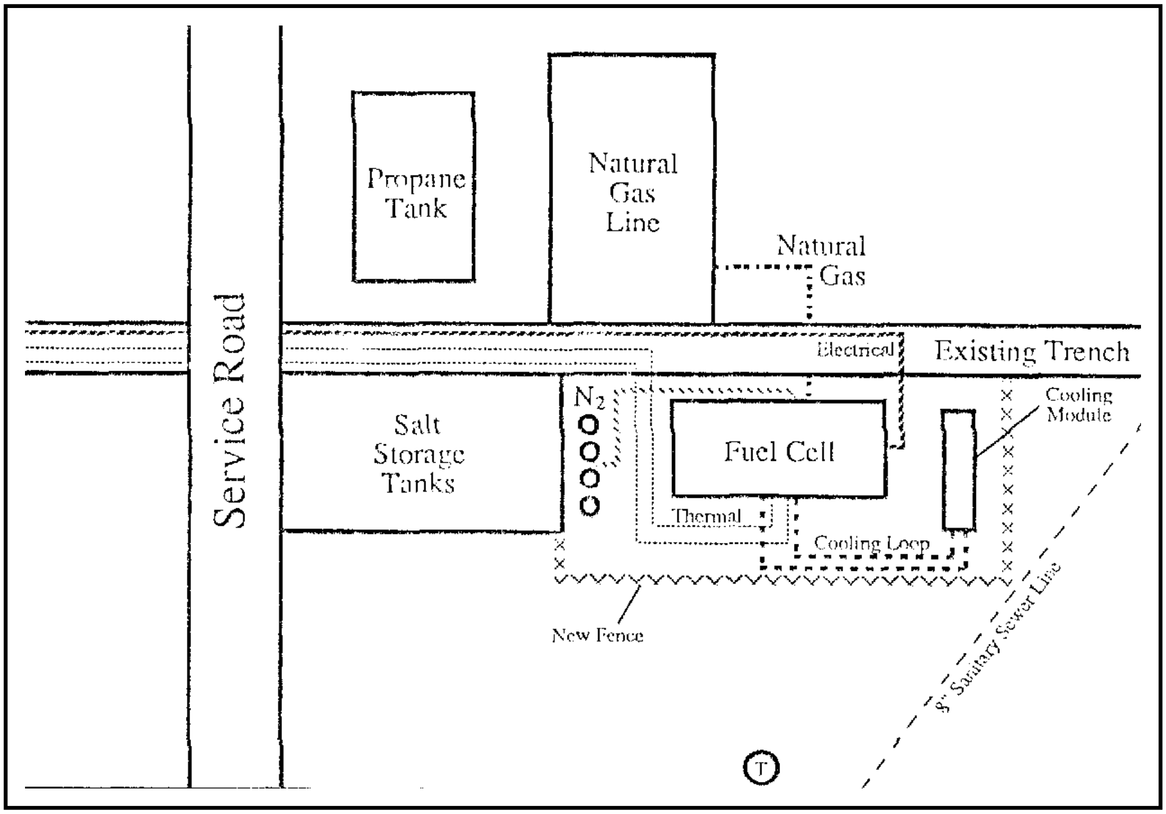

Figure 4. Picatinny Arsenal fuel cell layout and interfaces.

3 Economic Analysis

Picatinny Arsenal is located in New Jersey Central Power & Light Company's (JCP&L) service territory. Table 2 lists electric bills for 1993. The average rate ranged from 7.84 cents/kWh in March to 8.68 cents/kWh in September. The average electric rate paid by the Site in 1993 was 8.29 cents/kWh. The site is billed under rate schedule GT – General Service (Transmission), which is a time-of-use rate. The on-peak period is between 8:00 a.m. and 8:00 p.m. Monday through Friday throughout the year. The off-peak period is all remaining hours including weekends and holidays throughout the year. The summer period is June through September and the winter period is October through May.

Table 2. Picatinny Arsenal electricity consumption.

Date	Peak KW	On-Peak KWH	Off-Peak KWH	Total KWH	Total Bill	$/KWH
Jan 1993	10,430	2,001,125	2,567,250	4,568,375	$360,166	$0.0788
Feb 1993	10,412	2,195,375	2,786,875	4,982,250	$390,626	$0.0784
Mar 1993	10,255	2,287,250	2,646,000	4,933,250	$409,293	$0.0830
Apr 1993	9,922	2,234,750	2,920,750	5,155,500	$419,766	$0.0814
May 1993	11,445	2,344,125	2,680,125	5,024,250	$436,263	$0.0868
Jun 1993	12,215	2,488,500	2,876,125	5,364,625	$465,624	$0.0868
Jul 1993	12,285	2,835,000	3,608,500	6,443,500	$535,173	$0.0831
Aug 1993	12,215	2,589,125	3,080,875	5,670,000	$485,303	$0.0856
Sep 1993	11,540	2,371,250	3,019,625	5,390,875	$448,869	$0.0833
Oct 1993						
Nov 1993	9,467	2,030,875	2,499,000	4,529,875	$375,602	$0.0829
Dec 1993	8,820	1,915,375	2,753,625	4,669,000	$377,455	$0.0808
Total/Avg	10,819	25,292,750	31,438,750	56,731,500	$4,704,140	$0.0829

Table 3 presents the natural gas bills for Picatinny Arsenal in 1993. The average gas rate ranged from $3.32/MBtu in December to $3.69/MBtu in May with an annual average rate of $3.46/MBtu. The firm gas rate for the site is $7.20/MBtu. The difference between the firm and interruptible rates is $3.74/MBtu ($7.20 – $3.46/MBtu). Using a 90 percent capacity factor for the fuel cell, the annual gas consumption of the fuel cell would be 14,949 MBtu. The firm gas input fuel would cost an additional $55,909 ($3.74/MBtu * 14,949) over the interruptible gas rate in the first year. Typically, the Site has only 3 to 20 interruptible days in a year. For the worst case, the fuel cell would be down 10 days in January and 10 days in February. The loss of savings in this case would be $6,244 so that it is more economic to operate the fuel cell on interruptible gas.

Table 3. Picatinny Arsenal natural gas consumption.

Date	MBTU	Amount	$/MBtu
Jan-93	109,097	$394,144	$3.61
Feb-93	100,512	$337,337	$3.36
Mar-93	110,657	$371,334	$3.36
Apr-93	72,589	$262,420	$3.62
May-93	32,708	$120,692	$3.69
Jun-93	19,249	$69,818	$3.63
Jul-93	18,578	$62,775	$3.38
Aug-93	21,704	$73,252	$3.38
Sep-93	13,234	$46,973	$3.55
Oct-93	68,573	$236,893	$3.45
Nov-93	85,394	$294,873	$3.45
Dec-93	99,802	$331,464	$3.32
Total/Avg	752,097	$2,601,975	$3.46

Table 4 presents the specific electric demand and energy rates under rate schedule GT General Service (Transmission). This table also presents the first year electric savings from a 200 kW fuel cell based on a 90 percent electric capacity factor. It was assumed that the fuel cell outage hours during the on/off-peak periods occurred at the same percentages as shown in Table 4.

Table 4. Picatinny Arsenal electric rate schedule, Jersey Central Power & Light Schedule, GT–General Service/Transmission.

	Summer	Winter	
Demand Charge			
On-Peak ($/kW)	$9.22	$8.31	
Energy Charge*			
On-Peak ($/kWh)	$0.070180	$0.070180	
Off-Peak ($/kWh)	$0.060080	$0.060080	
Hours/Year			
On-Peak	1,040	2,080	35.6%
Off-Peak	1,871	3,769	64.4%
	2,911	5,849	
Savings/Year (90% ELF)			
On-Peak Energy	$13,138	$26,275	$39,413
Off-Peak Energy	$20,234	$40,759	$60,993
	$33,371	$67,035	$100,406
Demand (200 kW)	$7,376	$13,296	$20,672
Total Savings;	$40,747	$80,331	$121,078
Average $/kWh:	$0.0768		
* Includes $0.00216/kWh energy adjustment credit			

In other words, outage hours were not weighted more heavily in either the on-peak or off-peak periods, but were proportional to the number of period hours in a year. Total first year electric savings using a 90 percent electricity capacity factor was $121,078, which includes full demand charge savings. This works out to an average displaced electric rate of 7.68 cents/kWh ($22.50/MBtu). The reason that the average displaced electricity from the fuel cell is lower than the Site’s average electric rate (7.68 versus 8.29 cents/kWh) is that the fuel cell electric capacity factor is higher than the Site’s electric load factor (90 percent versus 60 percent). This has the effect of reducing the impact of the demand charge on the average cost per kWh because there are more kWh as a percentage of demand kW.

The potential energy savings based on the estimated thermal for the central power plant (100 percent) and an electric capacity factor of 90 percent were calculated. The potential energy savings from installing two fuel cells is also calculated. Table 5 presents the electric and thermal savings and input natural gas costs for Building 506. The net savings for 100 percent thermal utilization was $94,506 in the first year. The net savings for adding a second fuel cell was $189,012. Since demand savings from the fuel cell depends on it not being shut down during on-peak periods, a parametric analysis of achieving only 50 percent demand savings and no demand savings is also presented in Table 5.

The analysis is a general overview of the economics. For the first 5 years, ONSI will be responsible for the fuel cell maintenance. Maintenance costs are not reflected in this analysis, but could represent a significant impact on net energy savings. Energy savings could vary depending on actual electrical and thermal utilization.

Table 5. Picatinny Arsenal fuel cell savings.

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
A - One 200 kW Fuel Cell	90%	100%	1,576,800	7,357	$121,078	$25,750	$52,321	$94,506
A - Two 200 kW Fuel Cells	90%	100%	1,576,800	7,357	$242,156	$51,499	$104,643	$189,012
B - One 200 kW Fuel Cell	90%	100%	1,576,800	7,357	$110,742	$25,750	$52,321	$84,170
B - Two 200 kW Fuel Cells	90%	100%	1,576,800	7,357	$221,484	$51,499	$104,643	$168,340
C - One 200 kW Fuel Cell	90%	100%	1,576,800	7,357	$100,406	$25,750	$52,321	$73,834
C - Two 200 kW Fuel Cells	90%	100%	1,576,800	7,357	$200,812	$51,499	$104,643	$147,668

Assumptions:

Input Natural Gas Rate:	$3.50 /MBtu
Displaced Thermal Gas Rate:	$3.50 /MBtu
Displaced Electricity Rate:	GT General Service/Transmission
Fuel Cell Thermal Output:	700,000 Btu/hour
Fuel Cell Electrical Efficiency:	36%
Seasonal Boiler Efficiency:	75%

4 Conclusions and Recommendations

This evaluation has found that the central power plant (Building 506) is a good application for the PC25B on-site fuel cell. The thermal utilization of the fuel cell output is estimated to be 100 percent for up to two PC25B power plants. The electric can be hooked up to one of the two 2400/480 volt transformers at the central power plant.

The power plant(s) should be located next to the salt storage tanks on the north side of the building. At least two trees will have to be cut down if two fuel cells are installed. The existing trench will reduce costs of installation, but a heat trace should be installed on the pipe to the building.

Appendix: Fuel Cell Site Evaluation Form

Site Name: **Picatinny Arsenal**
Location: **Dover, NJ**
Contacts: **Hyman Izraeli**

1. Electric Utility: **Jersey Central Power & Light**
   Contact: **Rick Merkle**
   Rate Schedule: **GT General Service Trans. Voltage**

2. Gas Utility: **New Jersey Natural Gas Co.**
   Contact:
   Rate Schedule: **Interruptible**

3. Available Fuels: **Natural Gas/No. 6 Fuel Oil**
   Capacity Rate:

4. Hours of Use and Percent Occupied:

Weekdays	**5**	**Hrs**	**24**
Saturday	**5**	**Hrs**	**24**
Sunday	**5**	**Hrs**	**24**

5. Outdoor Temperature Range: **Design Temperatures: 6 °F to 90 °F**

6. Environmental Issues: **Base has jurisdiction on local permits; State requires air quality and water permits.**

7. Backup Power Need/Requirement: **Central plant has 750 kW generator; a few other small generators around base.**

8. Utility Interconnect/Power Quality Issues: **None**

9. On-site Personnel Capabilities: **JCP&L will provide maintenance; boiler plant personnel at site.**

10. Access for Fuel Cell Installation: **Access is adequate. A few trees may have to be removed.**

11. Daily Load Profile Availability: **Hourly steam load data for plant.**

12. Security: **Fence will be required by site.**

Site Layout

Facility Type: **Central Power Plant** Age: **> 80 Years**

Construction: **Cement Block and Steel**

Square Feet: **about 24,000 sq ft foot print with 2 - 5 levels**

See Figure 1

Electrical System

Service Rating: **Two 2400/480 transformers rated at 750 and 1500 kVa**

Electrically Sensitive Equipment:

Largest Motors (hp, usage):

Grid Independent Operation?: **Site will look for 200 kW load for grid independent operation.**

Steam/Hot Water System

Description: **Two Combustion Engineering boilers (150,000 lb/hr); One 75,000 lb/hr Mfg. unknown)**

System Specifications: **700 °F superheated steam @ 300 psi with no condensate return.**

Fuel Type: **Natural Gas/No. 6 Fuel Oil**

Max Fuel Rate:

Storage Capacity/Type: **None.**

Interface Pipe Size/Description: **6-in. pipe from softeners to deaerators**

End Use Description/Profile: **24 hours per day/364 days per year (1 day shut down/year)**

Space Cooling System

Description: **No absorption chillers. Steam is used for humidity control in summer.**

Air Conditioning Configuration:
- Type:
- Rating:
- Make/Model:

Seasonality Profile: **No data available**

Space Heating System

Description: **Heat exchangers and radiators in individual buildings.**

Fuel:

Rating:

Water supply Temp: **700 °F @ 300 psi**

Water Return Temp: **No condensate return**

Make/Model: **Various**

Thermal Storage (space?): **None**

Seasonality Profile: **Heating season: 10/1 to 5/15**

Billing Data Summary

ELECTRICITY

Period	kWh	kW	Cost
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			
11.			
12.			

NATURAL GAS

Period	Consumption	Cost
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10		
11.		
12.		

OTHER

Period	Consumption	Cost
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10		
11.		
12.		

CERL Distribution

Picatinney Arsenal
ATTN: ATTMA-AR-PW (2)

Chief of Engineers
ATTN: CEHEC-IM-LH (2)

Engineer Research and Development Center (Libraries)
ATTN: ERDC, Vicksburg, MS
ATTN: Cold Regions Research, Hanover, NH
ATTN: Topographic Engineering Center, Alexandria, VA

Defense Tech Info Center 22304
ATTN: DTIC-O

8
4/01

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)
02-2001

2. REPORT TYPE
Final

3. DATES COVERED (From - To)

4. TITLE AND SUBTITLE
Site Evaluation for Application of Fuel Cell Technology:
Picatinny Arsenal, NJ

5a. CONTRACT NUMBER
88-94-D-0020

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Michael J. Binder, Franklin H. Holcomb, and William R. Taylor

5d. PROJECT NUMBER
DACA

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/CERL TR-01-24

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
ARDEC
Building 506
Picatinny Arsenal, NJ 07806-5000

10. SPONSOR/MONITOR'S ACRONYM(S)
ASTMA-AR-PW

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

14. ABSTRACT

Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Researchers at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). CERL selected and evaluated application sites, supervised the design and installation of fuel cells, actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers for 29 of 30 commercially available fuel cell power plants and their thermal interfaces installed at Department of Defense (DoD) locations.

This report presents an overview of the information collected at Picatinny Arsenal, NJ, along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report.

15. SUBJECT TERMS
fuel cells
energy conservation
fuel technology alternatives
Picatinny Arsenal, NJ

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Michael J. Binder
Unclassified	Unclassified	Unclassified	SAR	26	19b. TELEPHONE NUMBER (include area code) (217) 373-7214